SOME CONSIDERATIONS CONCERNING THE PHOTOGENIC FUNCTION IN MARINE ORGANISMS

F. ALEX. McDERMOTT

WASHINGTON, D. C.

IN two very interesting papers, Professor C. C. Nutting[1] has brought forth evidence tending to show that in oceanic depths below the range of penetration of the sun's rays, there exists a dim, phosphorescent light, quite general in its distribution, radiated from various photogenic organisms of the abyssal regions, and having a definite and valuable significance for the life of animal forms at these depths.

That such a light actually exists is scarcely to be sanely doubted, in view of the evidence of the deep-sea explorations which have added so much to the knowledge of oceanic conditions. And that it has a purpose in the life of the forms inhabiting those portions of the ocean beds where it exists, seems to the writer equally undeniable, unless we accept Emerson's poetic reasoning that

"Beauty is its own excuse for being."

Just what its purpose may be in hermaphroditic, simple forms not provided with definite organs of sight, and indeed also in many higher forms, may, of course, still be a legitimate subject for investigation and consideration.

Professor Nutting's remarks have been of special interest to the writer in connection with some recent studies made by the latter on the general subject of biophotogenesis, with special reference to the Lampyridæ.[2]

[1] (*a*) "The Utility of Phosphorescence in Deep-sea Animals," AMER. NAT., Vol. 3, 1899, pp. 792–799; (*b*) "The Theory of Abyssal Light," *Proc. VII Cong. Zool.*, advance reprint, 1910.

[2] *Amer. Journ. Physiol.*, 1910 Vol. 27, pp. 122–151; *Canad. Entomol.*, 1910, Vol. 42, pp. 357–363; *Popular Sci. Monthly*, 1910, Vol. 77, pp. 114–121.

The coloring and photogenicity of the organisms found in the depths of the sea show some similarities to the corresponding features of life on land.

Take the family Buprestidæ, of the genus Coleoptera, of the order of insects. The insects of this family are probably the most brilliantly colored of any of the beetles, and are colored quite as brilliantly as the insects of any other genus. The colors cover a quite wide range of metallic, polished, glistening greens, blues, reds, coppery and golden; many of the smaller species wear more somber dark blues, browns and blacks, but as a class they are brilliant and showy. Obviously, these colors would be invisible in the absence of light, and need a light of considerable intensity to bring out their full value. Now we find that almost without exception these Coleoptera are diurnal; they attain their maximum activity during the brightest daylight, and fly but little at night. But one species has been reported to be luminous, and unless this report is pretty definitely confirmed there is grave reason to doubt its authenticity.

Now let us consider the Lampyridæ: The beetles of this family of almost eleven hundred species are in the great majority of instances, luminous; the non-luminous species form a decided minority of the true Lampyridæ. They are also, in the great majority of cases, mainly nocturnal in habit, hiding out of the sunlight during the day; those species which are markedly diurnal in habit are also those which are non-luminous, or in which the luminosity is relatively slight. In coloration, they show none of the bright metallic, showy colors of the Buprestidæ; black, gray, brown and yellow-brown predominate, with occasional red markings, yellow stripes and indistinct lines and spots. In them, the photogenic function possesses at least two definite significances: (1) it is an adjunct of the sexual organism of the insect, rendered of value to them by reason of their nocturnal habits, and (2) it has a protective value. In the larvæ it might also be considered to have an aggressive value, in attracting the snails, etc.,

on which they feed, but this argument would not hold for the imagos, which are much more active.

Most of the above statements apply with equal force to the Pyrophorini, the luminous Elateridæ of the tropics; these insects are herbivorous, however, and the aggressive significance does not hold for them.

It would seem, then, very probable that similar conditions obtain in the abyssal region, with its dim weird, phosphorescent light. The light produced by the Lampyridæ has recently been shown by Ives and Coblentz[3] to have the extremely high radiant efficiency of 96.5 per cent., against 4 per cent. for the best artificial illuminant. The spectrum of this light is a continuous band extending from the upper red to the lower blue with a maximum intensity in the yellow-green. This spectrum is of wider range than that of the sea-forms cited by Nutting,[4] but can hardly be of less efficiency. The light of the Lampyridæ is generally stated to be yellow, or greenish; there are some slight variations among different species, but in the main the lights are similar; it seems that a great many of the marine organisms also give a light of similar tone. Therefore colors whose wave-lengths are within the limits of those of the emitted lights of these forms, would be distinguishable in such a biophotogenic light. Although we do not yet know the full details of the process of the production of light by living forms, it is not too much to assume that Nature has developed it to a point very near to the maximum possible efficiency, and if such is the case, the luminous oceanic forms could emit a very penetrating illuminating radiation with very little expenditure of energy, and though this light might not be of any considerable intensity, as judged by our eyes, it could undoubtedly serve as quite a useful light to the large-eyed denizens of the deep.

The photogenicity of *Salpa, Noctiluca* and other such simple forms, which are without definite organs of sight,

[3] Bulletin of the U. S. Bureau of Standards, 1910, Vol. 6, pp. 321–336.

[4] *Supra b*, page 10.

presents other difficulties. It is not, however, necessary to the faculty of perception of light that definite organs should exist. It is a quite well-known fact that certain worms, bacteria, and other low organisms are able to detect ultra-violet rays to which the human organism is wholly without sensible response, and yet these actinotropic (if a coined word may be pardoned) forms show no definite organs such as might be adapted to the receiving and recording of the very short wave-lengths of ultra-violet light. If, then, existing organisms are known to be affected by ultra-violet rays for which they have no special sense-organs, it is certainly logical to assume that they and other forms may also be susceptible to the longer and more easily discerned wave-lengths of visible light—especially when those wave-lengths comprise mainly the rays possessing the highest illuminating effect —and without the necessity for the existence of "eyes" or other definite light-receiving organs. As a matter of fact *Noctiluca,* and numerous other marine organisms have been shown to be susceptible to light, although they possess no specific organs for this function so far as we have been able to make out.

Another consideration as to the purpose of the light presents itself here. We must consider the nature of the medium in which these creatures live. Water does not lend itself as readily as does air to the diffusion of the particles which produce the sensation of smell; and hence while odors, or speaking more properly, from the standpoint of marine organisms, flavors or tastes undoubtedly exist in the ocean water, they could not, on account of the water currents, lack of diffusion, etc., serve the purpose which the odors of land animals serve of giving indication of the presence and location of the creatures. It therefore would not be unreasonable to assume that in the gregarious simple luminous marine forms, the photogenic function takes the place to some extent of the animal odors of land forms.

To sum up, then:

From analogy to terrestrial forms, the photogenicity and coloration of marine organisms must play some essential part in their life histories;

The absence of definite organs for the reception of the radiations of light may not necessarily indicate that the forms from which they are absent are insensible to these radiations;

The photogenic function in certain simple marine forms may replace the olfactory function of terrestrial forms, to some extent.